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GRAVITY WATER SUPPLY AT THE CITY OF MANILA, PHILIPPINE ISLANDS

BY H. E. KEELER

The city of Manila is the chief city of the Philippine Islands in point of size and wealth and is the capital. It lies on the shore of Manila Bay, a circular body of water some thirty miles across, at whose gateway stands Corregidor, the Gibraltar of the Orient and probably one of the most strongly fortified places in the world.

The city of Manila has a population of a little over 300,000 people, the greater proportion of which are natives, although there is a large population of Japanese, Chinese and other Oriental races and a considerable number of Europeans and Americans.

Prior to the American occupation the Spaniards had control, and governed the Philippine Islands for over three hundred years.

One of the early Spanish gentlemen by name Antonio Careiedo, previous to his death in the year 1748, in his will created a trust fund of \$5000 gold for the purpose of constructing a water supply for the city of Manila. The trustees of this bequest for over one hundred years did nothing toward constructing a water-works system.

In the year 1867 Spain sent a new governor general to Manila. He discovered this bequest of Antonio Careiedo and, instituting inquiries, ascertained who the trustees were who had the bequest in charge. He directed that they give an account of the fund with the earnings thereof. Owing to the great length of time which had elapsed during which the fund was in their control, it should have amounted to a very large sum of money, but it was found, when the numerous charges and deductions claimed by the trustees were made, as the funds were depleted by the English when they took Manila and on several other occasions, that it amounted to about \$290,000 gold. The governor general ordered them to produce this money and directed the proper officers to proceed with the construction of a water system. However, the work was not begun until 1878. It took eleven years to get the enterprise under way even when it was pushed by this energetic governor general.

In 1878 the authorities began operations and constructed a system, which was placed in service in 1880. The plant as constructed by the Spaniards consisted of a pumping system with a maximum capacity of 6,000,000 gallons per twenty-four hours and a storage reservoir of 16,000,000 gallons. The supply of water was obtained from the Mariquina River at a point five miles above the city. This station and supply is still maintained as a reserve. It is used only for emergencies for the reason, among others, that the quality of the water is not of a satisfactory character.

When the Americans took control of the city of Manila and found that the service and quality of the water supply was unsatisfactory, it was decided that a new source of supply must be secured. A new supply was secured at Montalban at the foot of the mountains, about twenty miles from the city, at a point where the Mariquina River flows through a rocky gorge. The water shed which supplies this new source at Montalban has an area of about one hundred and eight square miles and has been withdrawn from settlement and made a public reservation. No one is allowed to live thereon; no one is allowed to visit the site of the works without a permit from the chief engineer, Department of Water Supply and Sewers; no one is even allowed to camp thereon unless it is a few negritos or what they call the wild men away up in the mountains. The quality as a rule is average, but there is trouble with mollusks, amoebae and decomposing vegetation, so that while it is a vast improvement over the original plant, it is not yet all that is desired. No method of filtration or treatment of the supply has as yet been tried on a large scale. Amoebae pass through all filters ever experimented with at Manila. Preliminary laboratory tests with ultraviolet rays have shown that they destroy bacteria and amoebae as well. The expenditure of the necessary funds for an experimental plant for determining the effect of these rays upon a considerable quantity of water has been authorized. It is hoped that a method of sterilizing water upon a large scale has at last been found. The new supply has a capacity to furnish 24,000,000 gallons per twenty-four hours.

A dam was constructed of stone and concrete across the mouth of the gorge. This dam is 187 feet long, 55 feet high and about 40 feet thick at the base and it is tied into the rocky sides of the cliffs. It forms a storage reservoir, oblong in shape with a storage capacity of about 220,000,000 gallons. Mariquina River water from the

original Spanish station was again used from June 28, 1911, to July 27, 1911, and from March 9, 1912, to May 24, 1912, the water department being obliged to put this reservoir and dam out of commission owing to structural and natural troubles which had developed in the new reservoir and to the deficiency in stream flow. It was found that there were seams in the rocky bottom and sides of the reservoir which caused such a large leakage that they had to cease using it until the leaks could be stopped. During this time the water department was obliged to put into service the old Spanish pumping station and supply the inferior water from the Mariquina River. The new supply was placed in service in 1909 and has been in continual use except for the short length of time required to make the necessary repairs just referred to.

The water is conveyed from the reservoir to the city through ten and one-half miles of 42-inch steel riveted pipe 0.203 inches thick. This pipe is laid with 2 feet of covering and follows the contour of the ground. It is fitted with 6-inch blowoff valves at low places and air valves at high points. Castiron manholes are placed every 500 feet for the purpose of inspection or repair. The pipe was tested to 100 pounds per square inch and the working pressure in no case exceeds 60 pounds. It was dipped in a bath of hot mineral asphalt to prevent corrosion. The plates were received in Manila flat and were rolled into shape and riveted in the local shops. No valves were placed in this line.

At the end of this ten and one-half miles of steel line, the water passes into a concrete-lined conduit about four and one-half miles in length. This conduit is shaped somewhat like a horseshoe, about 5 feet in diameter with an area of about 20 square feet, and is supplied with inspection openings at frequent intervals. This conduit at one point is carried under the bed of the Dulutan River, at another point it is carried over a small river by a 60-foot concrete arch bridge; at another point it is carried 180 feet below the surface of the ground. Where the line crosses the Mariquina River it is carried in a 36-inch castiron main which was laid in a copper dam in the regular way without the use of ball joints.

The water is delivered into two receiving reservoirs located about one and one-half miles from the city proper. One of these reservoirs has a capacity of 18,000,000 gallons and the other 54,000,000 gallons. The larger reservoir is rectangular in plan, measuring 509 feet by 764 feet and is 20 feet deep; its construction involved the

excavation of 275,000 cubic yards of material, the placing of 9,000 cubic yards of concrete and the use of 120,000 pounds of steel. The gatehouse inlet and outlet are so arranged that water may be drawn directly from the head works, directly from the reservoir or from both at the same time. The water surface is 110 feet above sea level (Manila being at elevation 8 feet) which gives a very satisfactory pressure all through the city. The smaller reservoir is connected with the original Spanish pumping station by a 26-inch castiron pipe line and an irregular size tunnel. From these reservoirs the water is delivered into the distribution system. The distribution system is proportioned for a capacity of 30,000,000 gallons per day and consists of about one hundred and ten miles of castiron mains ranging from 42-inch to 6-inch in diameter. No pipe smaller than 6-inch is laid. This conforms to the best modern American practice. All mains are laid with 2 feet cover and are supplied with American made valves. There are connected with the distribution system 630 modern American made double and threeway nozzle fire hydrants with 6-inch connections. These hydrants are exclusively for the use of the fire department and some city departments. There are also connected to the distribution system 230 public singlenozzle hydrants for the use of the poor people, flushing of sewers, street sprinkling and any other general purpose desired. They have now about 6000 service connections ranging in size from 1 to 6 inches. All service connections are made by the city department at the expense of the property holder and the cost is figured from the pipe line to the property line. All plumbing is done by licensed plumbers and their work is carefully and efficiently inspected by City Plumbers.

The water furnished from service connections is sold by cubic meters and by meter measurement only. The meters are paid for by the consumer and are all set by the city and kept in repair by the city at the expense of the consumer. The charge for water when reduced to gallons and U. S. currency is as follows:

Nine cents gold per 1000 gallons for the first 4000 gallons per month.

Eight cents gold per 1000 gallons for all water supplied and passing the meter in excess of the first 4000 per month.

Bills for services are made out by the water department and collected by the city collector. The writer is informed that their loss from delinquent consumers is less than one-fifteenth of one per cent, which is certainly a very creditable showing. Of course they

use the old standard American plan of shutting off the supply to bad or delinquent customers and they only deal with owners, no tenants.

The native population and poor people are supplied with free water from any of the 230 public singlenozzle hydrants heretofore referred to. The people take their supply in buckets or any other receptacle that they may have and carry it from the hydrant to their homes. All public wells in Manila have been condemned, filled up and put out of service, and all the inhabitants are required to use the public supply or distilled water as furnished by the government. The Insular government owns and operates a large plant for furnishing distilled water, ice and refrigeration service. Distilled water is furnished when bottled the army and navy free and to others at a charge of one-half cent per litre and is delivered in sealed bottles or cans in the same way that ice is delivered. Most of the white or foreign population, that is to say the Americans and Europeans and some of the natives, use this supply.

Extensions to the water system are made mostly from the income of the plant and cost about \$4000 per mile of main laid for the 6-inch size. The plant has cost about \$3,000,000 including a valuation of \$500,000 on the original Spanish plant. This money was provided by an issue of bonds.

There are four artesian wells in Manila; two being owned by the United States government and two by private parties. They are 8 inches in diameter and about 700 feet deep. The water does not flow to the surface but does come up to within pumping distance. There are wells used at the Fort McKinley or on the U. S. military reservation which is about five miles from Manila.

The observed result upon the health of the community due to the introduction of the improved water supply has been very marked. There has been a decided reduction in water borne diseases and while the water supply is not entitled to all the credit, it is entitled to a good share of it. Manila has been able to make an excellent showing in its death rate. The reports show as follows:

Among the whites only 12.25 deaths per 1000 population.

Among the natives 32 deaths per 1000 population. The report for 1912 shows a still greater improvement. Of this large death rate among the natives, 63 per cent are of those under five years of age.

This is due to the lack of care and proper attention to the health of children. The death rate compares very favorably with the re-

ports from Chicago, which are 14.25 per 1000, San Francisco 15, New York 16.5, Glasgow 18 and Belfast 22. Of course the white population of Manila contains a large proportion in the prime of life, when the longevity expectancy is greatest.

Again the excellent sewer system in Manila is entitled to some of the credit for the showing they are able to make. In this connection it would be proper and the writer ventures to give a short description of the sewer system as it is in operation in Manila.

Manila is said to be the only city of importance in the Orient, or Far East, that has a complete, up-to-date modern sewer system. The city has constructed at a cost closely approximating \$2,000,000 a combined pumping and gravity system. They have fifteen miles of storm water gravity sewers, ranging in size from 12-inch to 96-inch, emptying directly into the river and bay, and seventy miles of sanitary sewers, ranging in size from 8-inch to 72-inch, emptying finally into the bay about two miles off shore. Vitrified pipe is used on all sizes 21-inch and smaller; all pipe larger than 21-inch is made of cement. Owing to the fact that the city is nearly level, it is necessary to carry sanitary sewage to central points and then pump it to a higher level by electrically operated centrifugal pumps to a final delivery into the bay. They have seven of these pumping stations. Extensions to the sewer system are made by the city and generally paid for out of the current revenue. A charge for service is made for all connections to the system equal to 4 cents gold per 1000 gallons for all water supplied the premises as shown by the water meter attached to the customer's service. The consumer may, if desired, furnish a separate meter to measure all water not discharged into the sewers; in such cases no charge is made for the water so measured. All houses are by law required to connect to the sewer system, but when the writer was in Manila in December, 1912, this law was temporarily inoperative owing to injunction proceedings which have not yet been finally decided. (This injunction has been since dissolved.) No sewers were in Manila outside of a few drains prior to American occupation and the great majority of the natives and poor people are still using their pail, vault or tank, which has to be allowed until the courts will permit the enforcement of the compulsory law requiring connections to the sewer system. All sewer connections are of 6-inch vitrified pipe and are made by the sewer department and a charge made to the owner of the premises equal to the cost only. Each is figured at one-half the width of the street.

In conclusion it would seem that these two very important public services have been ably handled by the Americans, and much accomplished in a very short time. It is with pleasure that the writer notes that the superintendent of this service in both departments is a member of this association, namely, Mr. A. Gideon, chief engineer, department of sewer and water works construction.

The writer is under many obligations to Mr. Gideon for the facilities he placed at his command and for courtesies extended while in Manila.